

What's All This 4-To-20 mA Stuff, Anyhow?

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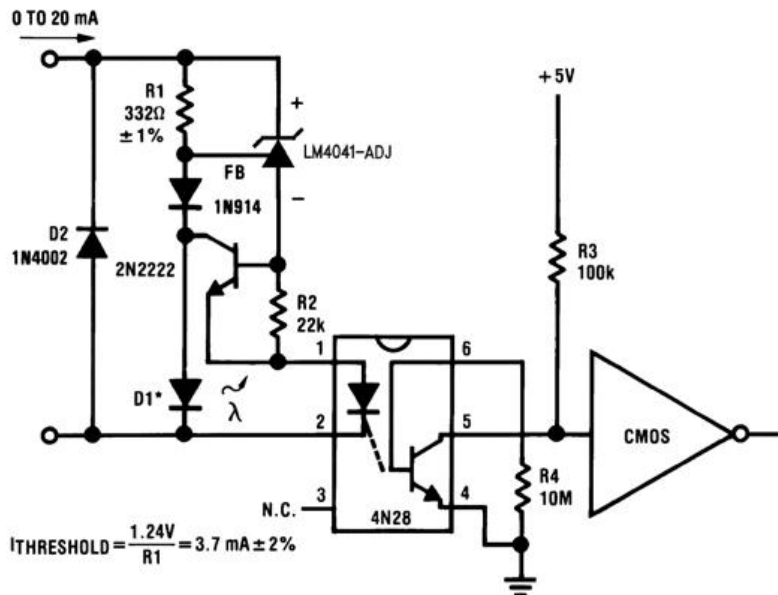
June 09, 2011

About 30 years ago, some guy told me he had a 4-to-20 mA current source. He wished he could tell if the current was out of range—or if the wire was broken! But nobody could tell him how to detect this. Well, if you want to wave a red flag in front of a bull, just tell me that there's an analog function and nobody knows how to do it. So I began to figure. How can we tell if a 4.0-mA current shifts down to 3.70 mA or less? If we could tell that, that would be an illegal condition.

I decided to use Bob Widlar's new LM10, which incorporates a voltage reference and an op amp. Surely I could invent a trick circuit to detect and transmit the error when the current gets too small. I sketched and fiddled and invented a circuit that worked. The customer agreed that it worked.

I also submitted this as a sort of "Idea for Design" to one of the instrument and industrial magazines, because we knew its readers always used a lot of "4-to-20 mA." So the magazine published that circuit. About three months later, we got a nice letter in AWE, because the reader response to this little circuit had drawn more interest than the magazine had ever seen before. Well, I guess so.

These days, the LM10 is still made and sold, but at \$2.30, it's a little more expensive than you really need for such a simple function. When we brought out the inexpensive (37 cents in quantity) LM4041-ADJ, I figured, "That ought to be able to do it, too." The LM4041-ADJ has a little gain stage and a 1.2-V reference, so it will perform those functions ([see the figure](#)).



Key Specs

The 4N28 has fairly mediocre gain (0.1 to 0.3), but it's adequate to put out a little flag that can be detected down near "ground." The LM4041-ADJ detects the 4.0-mA current through the 332Ω and turns on the 4N28. If that current drops below 3.7 mA, the LM4041 turns the opto off. Even a simple circuit can perform a very useful function. You don't have to try to find a 30-year-old magazine.

If you want to check the actual level at which this circuit trips and detects, you'll want a little triangle-wave tester to put in calibrated currents both above and below 3.7 mA. If the output duty cycle is exactly 50%, you'll know that the threshold is correct. You could trim if you wanted better than 2% accuracy.

I used to work for Teledyne, and if you know your Greek, you'll know it means "distance and force." Well, this circuit puts out a small force even isolated hundreds of volts distant, above or below ground. No galvanic connections. So, isolation does not mean poor accuracy or great expense.